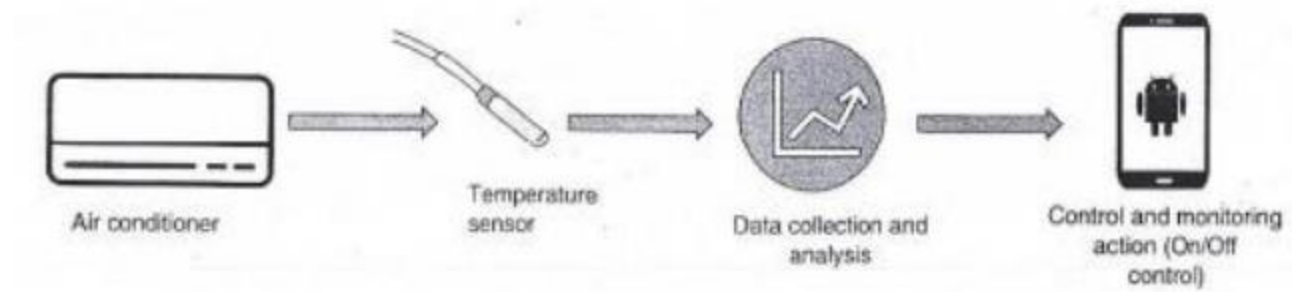


Ch:03

## Emergence of IoT:

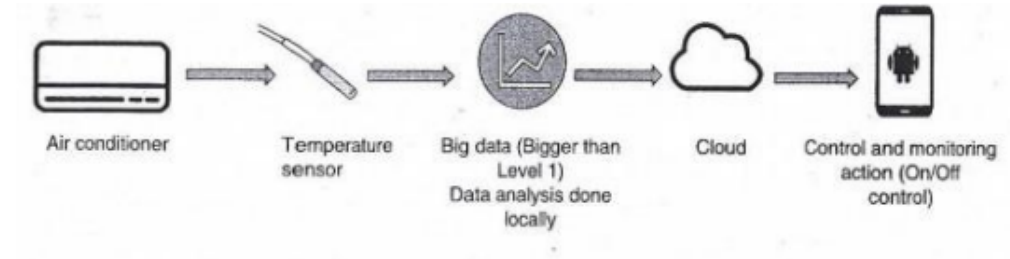
- IoT Growth- A statistical View,
- Application area of IoT,
- Characteristics of IoT,
- Things in IoT, IoT stack,
- Enabling Technologies, IoT challenges,
- IoT levels,
- Cyber physical systems versus IoT,
- Wireless sensor Network with IoT

- 1 Level 1
- What is Level 1 IoT application all about?
- As one could guess, it is of minimal complexity and the easiest to build. The application has one sensor a device to sense.
- It could be a temperature sensor, pressure sensor, etc. The data sensed is stored locally and the data analysis is done locally.
- Monitoring/ control is done through an application (.apk or webapp).
- This is used for simple applications involving limited or no complexity.
- Data generated in this level application is not huge (i.e., not a big data).
- All the control happens through the Internet.
- A simple example scenario is presented in Fig. 1.19, where the temperature sensor senses the room temperature and the data is stored and analysed locally.
- Based on the analysis, the control action can be triggered through mobile application or it can help in monitoring the status.



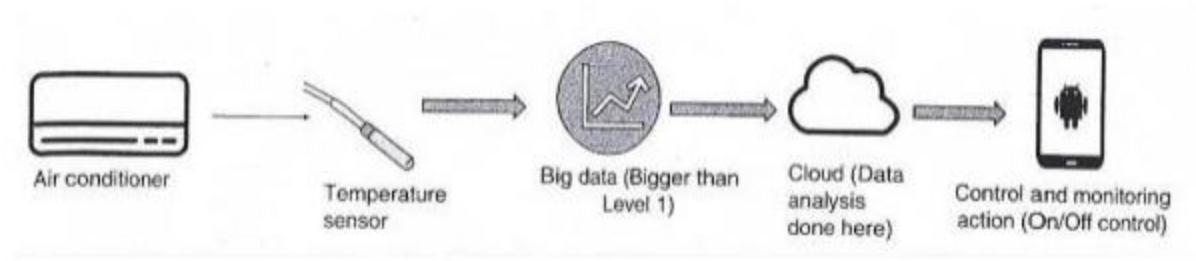
**Figure 1.19 Level 1-IoT application**

- Level 2
- The second level is slightly more complex than the previous level.
- Here, the data is more voluminous and hence, cloud storage is preferred. The frequency of sensing done by the sensor is faster.
- This means that the sensing happens faster and the number of times sensing is done would be much more than Level 1.
- The analysis is carried out locally, while cloud is meant for storage only. Based on the data analysis, the control action can be triggered through the web application or mobile application.
- Some examples are agriculture applications, room freshening solutions based on odour, etc. Figure 1.20 shows the Level 2 IoT application of an air conditioner.
- The sensor reads the room temperature at a better pace and rate than Level 1; the data then goes on to the cloud for storage. Analysis is done locally and the action is triggered through the mobile application.



**Figure 1.20 Level 2-to-IoT application**

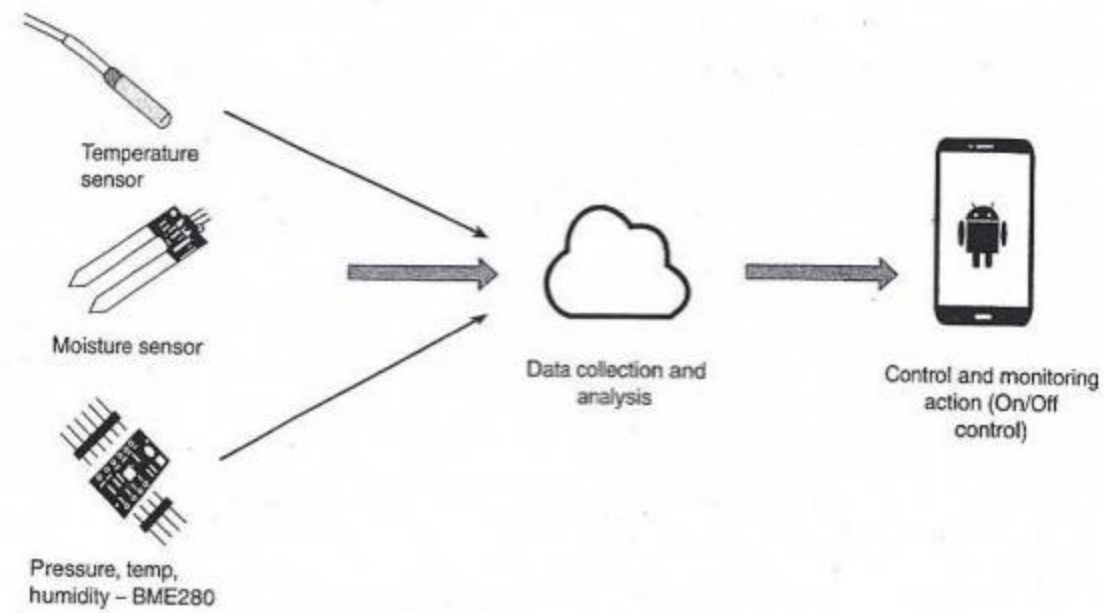
- Level 3
- In level 3 also, since the data is voluminous, frequency of sensing done by the sensor is faster and the data is stored on the cloud.
- The difference is that the analysis is carried out on the cloud.
- Based on the data analysis, the control action can be triggered through the web application or mobile application.
- Some examples are agriculture applications, room freshening solutions based on odour, etc.
- , where analysis of data occurs in the cloud. Figure 1.21 shows an example of Level 3 IoT application.



**Figure 1.21 Level 3-IoT application**

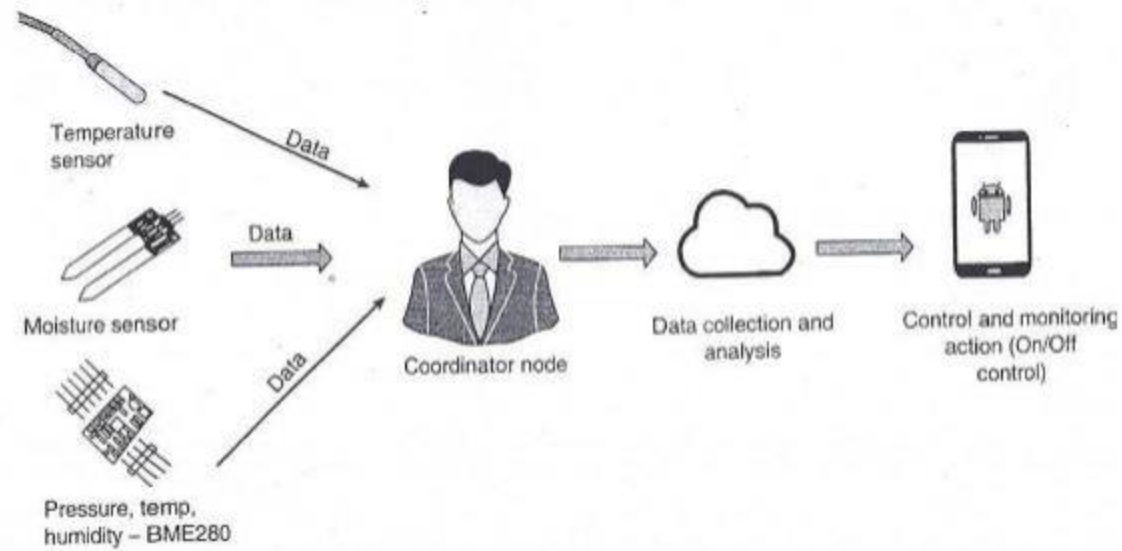


- Level 4
- With every passing level, the volume of data increases and hence the rate at which it is sensed also increases.
- At this level, multiple nodes are present which are independent of each other.
- These nodes upload data to the cloud.
- As an example see Fig. 1.22.
- All the sensors upload the read sensory inputs.
- Here, cloud storage is preferred as data is huge.
- Analysis is also carried out on the cloud and based on the analysis carried out, the control action shall be triggered through a web application or mobile application.



**Figure 1.22 Level 4-IoT application**

- Level 5
- At this level, the amount of data is extensive and is sensed much faster.
- Multiple nodes are involved in the applications categorized under Level 5 and these nodes are independent of each other.
- The sensing of data and its storage is the same as in all the previous levels.
- When an application is completely cloud oriented, it is computationally intensive in real time.
- Based on the data analysis, the control action can be triggered through web application or mobile application as in all other levels.
- Figure 1.23 shows an example of Level 5 IoT application.

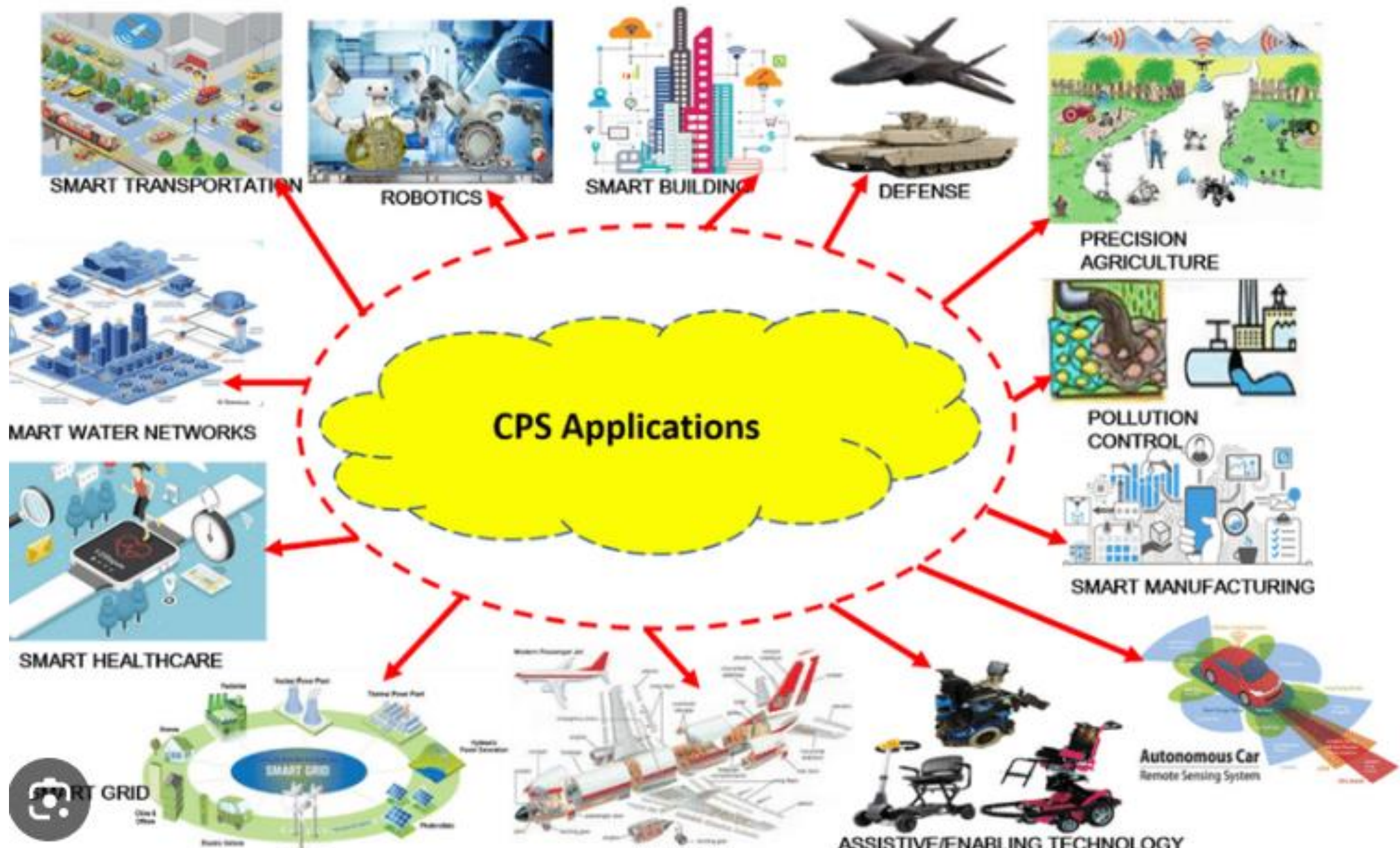


**Figure 1.23 Level 5-IoT application**

# Cyber physical System versus IoT

- An important question is if IoT is the same as Cyber Physical System (CPS).
- The answers available are not concrete and hence it is really challenging to find the differences between these two concepts.
- There is a misconception that both the terms are the same.
- It is all about "things" getting identified through an address or identifier.
- The "thing" can also be accessed from anywhere, anytime by an authorised party.
- The information (i.e., the sensed data) can be as simple as an RFID read.

- Hence, the complexity involved in IoT applications is minimal.
- For complex levels of operation and to address larger network of "things", a new term called Cyber Physical System, or CPS, has been introduced.
- It is important to note that CPS is not IoT.
- CPS has IoT as one of its components.
- CPS is more complex than IoT and is much more challenging.
- It is a combination of multiple engineering domains coming together, which includes computer science, electronics, electrical, and mechanical engineering.
- The flight of an aeroplane can be seen as a CPS which involves multiple domains of engineering. It also has IoT as one of the components. Obviously, the complexity increases by volumes.
- CPS is much more autonomous than IoT, taking appropriate decisions as and when needed.
- It is not merely about identifying "things"; it is more about understanding and taking decisions in a more dynamic way.

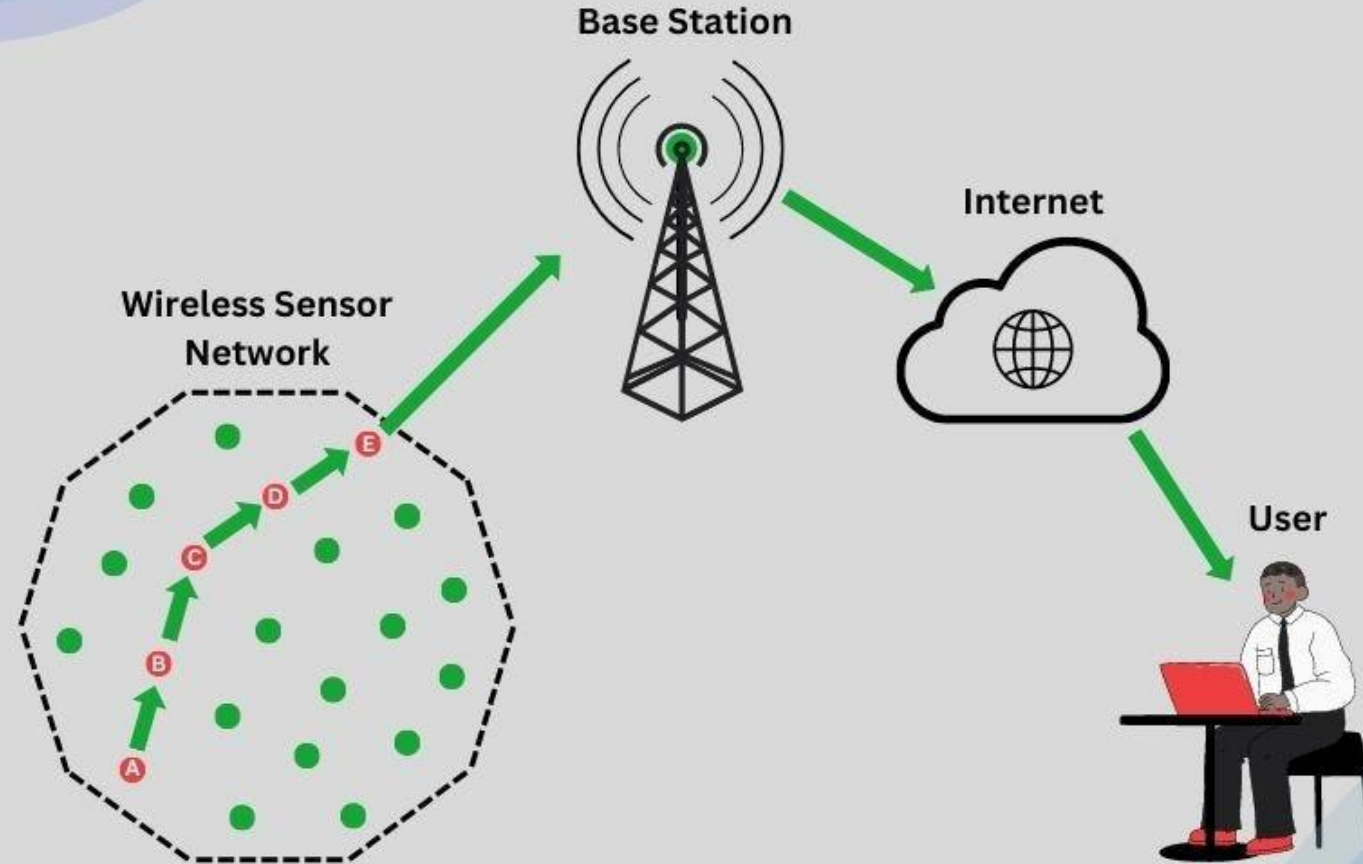


# Wireless Sensor Network versus IoT

- wireless sensor networks (WSNs) is a network.
- The network is built with multiple autonomous sensors; the sensors could be pressure, moisture, temperature, humidity, sound, and so on.
- All the sensed data are passed to a centrally located server.
- **Wireless sensor networks (WSNs) are designed to sense, collect, and transmit information from the environment to the base station.**
- The data passing happens in a coordinated pattern.
- WSN is basically composed of nodes (from a few to a few thousand).
- Each node has one or more sensors.
- In short, we can say that WSN is all about coordinated data collection.
- On the other hand, IoT is much more than just data collection and the systems are more intelligent.



# Wireless Sensor Networks for IoT Applications



Thank You